Archives of Rehabilitation Research and Clinical Translation (2024) 6, 100359

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

**Archives of Rehabilitation Research and Clinical Translation**

Archives of Rehabilitation Research and Clinical Translation 2024;6:100359

Available online at www.sciencedirect.com


Original Research

# Exploring the Effect of Preamputation Employment and Income on Ambulation in Dysvascular Lower Extremity Amputees After Amputee Rehabilitation: A Retrospective Cohort Study

**Jessica Murphy, PhD [a], Emiliyan Staykov, BSc [b], Amber Monteiro, BEng [c], Sandra Monteiro, PhD [d], Celina Lin, MD [a]**

[a] *Division of Physical Medicine and Rehabilitation, McMaster University, Hamilton, Ontario, Canada.*
[b] *Undergraduate Medical Education, Michael G. DeGroote School of Medicine, McMaster University, Hamilton, Ontario, Canada.*
[c] *Department of Chemical Engineering, McMaster University, Hamilton, Ontario, Canada.*
[d] *Department of Medicine, Division of Education and Innovation, McMaster University, Hamilton, Ontario, Canada.*

**KEYWORDS**
Amputation, surgical;
Rehabilitation;
Retrospective studies;
Social Determinants of health;
Walk test

**Abstract** *Objective:* To assess the relationship between 2-minute walk test (2MWT) distance, employment status, and median household income in adult dysvascular amputee patients after a 6-week rehabilitation program.
*Design:* Retrospective cohort study.
*Setting:* Amputation rehabilitation program.
*Participants:* In total, 505 patients were included in the analysis. Most (71.1%) were men and had below-knee amputations (78.3%); the average age was 65.3±11.6 years.
*Interventions:* Not applicable.
*Main Outcome Measures:* 2MWT distance at discharge.

*List of abbreviations:* 2MWT, 2-minute walk test, 6MWT, 6-minute walk test; GLM, general linear model; ICF, International Classification of Functioning, Disability and Health; SDH, social determinants of health.

Supported by the War Amps Canada, Ottawa, Ontario [22-06], 20020503.
**Disclosure:** S.M. discloses grants from the Medical Council of Canada (2022-2024), PSI Foundation, and the McMaster Gender & Health Education Initiative; consulting fees from KA imaging (Dr David Koff); payment of travel expenses from the professional development fund of the MERIT and CE program, Department of Medicine; and a leadership role for the Sim One Canada Board. C.L. discloses an Early Career Award from Hamilton Health Sciences. The other authors have nothing to disclose.
Cite this article as: Arch Rehabil Res Clin Transl. 2024;6:100359

https://doi.org/10.1016/j.arrct.2024.100359

*Results:* Men (68.3±32.6m) and below-knee amputation amputees (70.9±32.0m) walked significantly further than women (58.8±30.0m; *P*=.003) and above-knee amputees (47.2±25.7m; *P*<.001), respectively. A significant negative correlation was found between 2MWT distance and age (*r*=−.32; *P*<.001) as well as time from consultation to admission (*r*=−.23; *P*<.001). An unadjusted general linear model (GLM) revealed that employment status ($F_{2,446}$=17.47; *P*<.001) but not income ($F_{4,446}$=.714; *P*=.58) was statistically significantly associated with 2MWT distance. An adjusted (age, sex, time from consult to admission, and amputation level) GLM revealed employment status remained significant ($F_{2,434}$=5.59; *P*=.004) and income remained insignificant ($F_{4,434}$=.43; *P*=.784). Differences in 2MWT distance between employment and income groups did not meet clinical significance.

*Conclusions:* Preamputation employment appears to be associated with postrehabilitation outcomes.



The amputation of a limb is a major, life-changing procedure most often caused by vascular disease (eg, diabetes mellitus and peripheral artery disease), trauma, or cancer.[1] Although an amputation is a large adjustment physically, emotionally, and psychologically, attending physical rehabilitation can aid in improving mobility,[2] independence, muscle power,[3] 1-year survival, and the likelihood of being discharged home.[4] Health outcomes after a course of physical rehabilitation are affected by medical and nonmedical factors (ie, social determinants of health [SDH]).[5,6] Medical factors shown to affect postrehabilitation outcomes include comorbidities,[2,7-9] baseline physical fitness,[8,10,11] body mass,[2] amputation level,[9,12-14] and time from amputation.[9,15,16] Nonmedical factors known to affect outcomes include social support,[2] sex,[7,12,17] and age.[2,7,9,12,14,17] The importance of considering such factors when interpreting and determining desired functional outcomes after rehabilitation from an amputation have been outlined in the literature.[18,19]

This perspective supports the World Health Organization's International Classification of Function, Disability and Health (ICF).[20] According to the ICF, disability and functioning are outcomes from the interactions between "health conditions (eg, diseases, disorders, and injuries) and contextual factors (eg, social, cultural, or institutional)."[20] In an amputee population, this would suggest that disability and function are outcomes of medical (eg, comorbidities, amputation level, and type) as well as social factors (eg, race, income, and living condition). By taking this perspective in rehabilitation, we can provide patient-centered care and understand a patient's "capacity" (ability to perform a task at their highest ability) versus their "performance" (what can be achieved by a patient within their environment).[20]

Earlier research has explored the effect of various factors on rehabilitation outcomes and the effect of amputation on postsurgery employment/return to work.[21,22] However, there is a paucity of research exploring the effect of preamputation employment status and income on postamputation outcomes after rehabilitation in amputee patients. As such, the purpose of this study was to answer the question "Does 2MWT distance at discharge vary by preamputation employment status and median household income in adult dysvascular amputee patients after a 6-week rehabilitation program?"

## Methods

### Design

After receiving local research ethics board Hamilton Integrated Research Ethics Board (HiREB) approval (REB #14418), a retrospective chart review was performed on medical files of all patients who had completed the rehabilitation program between January 2010 and July 2022.

### Setting

The amputee rehabilitation program is conducted out of a major rehabilitation center in Southern Ontario. The 6-week program is run by an interdisciplinary team and designed using a biopsychosocial approach to health care. More information about the structure of our program can be found in appendix 1.

### Participants

Patients were considered eligible for inclusion only if they (1) had a unilateral or bilateral lower-limb amputation because of diabetes and/or peripheral artery disease (dysvascular amputation); (2) had been fitted for and received a prosthesis fabricated at our center; and (3) had completed the rehabilitation program between January 2010 and July 2022. Patients were excluded if they (1) did not fully complete the rehabilitation program; and/or (2) were aged <18 years at the time of amputation. If 2MWT distance at discharge was not available, patients were not included in the statistical analysis (see below). Given the design of this study, the local research ethics board deemed that patient consent was not required.

### Primary outcome

The primary outcome was 2MWT distance at discharge (measured in meters).[23] The 2MWT is a shorter version of the original 6-minute walk test (6MWT) used when patients cannot walk for 6 minutes or when space is limited.[24] Research has shown that the 2MWT is highly predictive of the 6MWT, making it an appropriate replacement in these situations.[24]

Originally viewed as an endurance measure,[25] walk tests such as the 6MWT and the 2MWT are now viewed as a broad measure of mobility and function.[26,27] Such tests are common outcomes measures in amputation rehabilitation programs[28,29] and are considered in alignment with the WHO's ICF.[30] The 2MWT has been identified as one of the best measures to assess function in amputees,[31] and it has been shown to be responsive to change in this population.[17] Discharge 2MWT scores in amputees after rehabilitation are weakly correlated with the functioning subscale of the Medical Outcomes Study 36-Item Short-Form Health Survey, a measure of overall function.[17] Scores on the 2MWT are also associated with overall activity in terms of daily steps taken in community-dwelling amputee patients.[32,33]

In the rehabilitation program involved in this review, patients perform the 2MWT in a wide, tiled hallway outside of the rehabilitation gym. The hallway is marked at each meter for 25 m, when patients reach the end (25 m). Patients are asked to walk in a straight line at a normal walking speed until they reached the end of the hallway, where they are asked to turn around and walk back down the hallway. They repeat this as many times as possible for 2 minutes, and staff monitor the distance walked. Patients perform the 2MWT while wearing their prosthesis and using any gait aid that they are using at that time. Patients who were unable to complete the 2MWT or did not walk at least 1 m are marked in this review as walking 0 m. Patients in the current study either used no gait aid, a rollator walker, cane (s), or crutches during their discharge 2MWT. Patients were not separated from their walking aid because the investigators were interested in 2MWT distance at discharge regardless of if, or what, walking aid was used.

### Data collection

Patient files were reviewed by 2 study team members (*ES and MG); any questions that arose based on eligibility or outcome measures were addressed by the principal investigator (*redacted*). Information was available through physician consultation notes, in-patient program notes, and discharge statements. The following factors were consistently available in patients' files and were included in the analysis: age at amputation, sex, postal code, employment status, amputation level, and days from consultation to program admission. Patient postal codes were used to obtain an estimated 2020 median household income (before taxes) using Statistics Canada's Census Profile.[34]

### Variable definitions

Employment status was categorized as "working," "not working," or "retired." Those in the "working" category reported that they were actively working in either a full-time or part-time position prior to their amputation; stay-at-home parents were also included in this category. Those in the "not working" category included patients who were on long-term disability or unemployed immediately prior to their amputation. Income levels were categorized by median household income, according to postal code, as <$66,000, $66,000 to <$86,000, $86,000 to <$106,000, $106,000 to < $126,000, and ≥$126,000. One patient who lived on an Indigenous reserve could not be included in the income analysis because income on the reserve is not reported in census data. The variable "time from consultation to admission" in the current study is similar to "time from amputation" in earlier research. In the rehabilitation program of interest, a patient is seen for their consultation after their amputation, and they enter the program when they are physically able.

### Data analysis

All data analyses were conducted using SPSS version 26.[35,a] Data were first explored for linearity, homoscedasticity (constant variance), normality, and independence. Means, standard deviations, and percentages were used to describe the sample. A 2-tailed Pearson correlation analysis was used to assess the relationship between 2MWT distance and age, as well as 2MWT distance and time from consultation. Separate univariate analysis of variance was used to explore the difference in 2MWT distance between sexes and amputation levels. Independent variables that showed significance in these tests were entered into an adjusted general linear model (GLM) to assess the relationship between employment status, median household income, and 2MWT distance, while accounting for variables known to affect 2MWT distance. An adjusted and unadjusted GLM with pairwise comparisons was performed. Clinical significance between patients was determined based on earlier literature calculating minimal clinically important difference (37.2m)[36] and minimal detectable change (34.3m).[37]

## Results

A total of 597 patients were deemed eligible based on diagnosis of vascular disease. The records of 48 patients were removed because of missing 2MWT data, leaving 549 patients. Statistical outliers in the 2MWT distance were explored using a box and whisker plot. Results revealed that values ≥159 m were considered statistical outliers. Standardized residual statistics were used to confirm that no other residuals were present in the dataset (minimum=−3.25, maximum=2.84). Four patients were removed from the analysis based on this outlier criterion, leaving a total of 545 records. Of those, 40 patients had bilateral amputations, an independent samples *t* test revealed that bilateral amputation patients (48.6±39.5m) had significantly lower 2MWT distances at discharge than unilateral amputation patients (65.7±32.2 m; $t_{543}$=3.18; $P$=.002). Given this difference, these 40 patients were removed, leaving 505 patients.

Collinearity statistics confirmed that multicollinearity was not a concern because tolerance and variance inflation factor values were all >0.1 and <10, respectively.[38] Durbin−Watson tests confirmed that the data met the assumption of independence of observations (Durbin−Watson value=2.07). The histogram of standardized residuals indicated that the data contained approximately normally distributed errors. This was also confirmed using the normal P-P plot, which showed points resembling a linear relationship. A scatterplot of standardized residuals showed that the data met the assumptions of homogeneity of variance and

**Table 1** Patient sociodemographic and treatment characteristics.

| Characteristic | n | Mean (SD) or % |
|---|---|---|
| Age at amputation (y) | 504 | 65.6 (11.6) |
| Days from consult to program admission | 498 | 140.1 (148.5) |
| Male sex | 366 | 72.5% |
| Below-knee amputation | 395 | 78.2% |
| Walking aid | | |
| No aid | 39 | 7.9% |
| Walker | 286 | 57.9% |
| 1 cane | 123 | 24.9% |
| Multi-cane or crutches | 46 | 9.3% |
| Nonambulatory | 10 | |
| Missing | 1 | |
| Median 2020 household income, CAD | | |
| <$66,000 | 126 | 27.3% |
| $66,000 to <$86,000 | 141 | 30.6% |
| $86,000 to <$106,000 | 80 | 17.4% |
| $106,000 to <$126,000 | 81 | 17.6% |
| ≥$126,000 | 33 | 7.2% |
| Census information not available | 1 | |
| Missing | 43 | |
| Employment status | | |
| Working | 56 | 11.3% |
| Not working | 154 | 31.0% |
| Retired | 287 | 57.7% |
| Missing | 8 | |

Abbreviation: CAD, Canadian dollar.

linearity; homogeneity was further confirmed with the Breusch–Pagan test ($\chi^2$ [1]=3.072; $P$=.08). If patients had missing demographic, employment, or median income data (whether because of missing postal code or no income for postal code in Statistics Canada database), that patient was excluded from the particular analysis.

Of the 505 patients included in the analysis, the majority were men (72.5%) with a below-knee amputation (78.2%) and an average age of 65.6±11.6 years. Most patients (30.6%) fell within the median household income bracket of $66,000 to <$86,000 and were retired prior to their amputation (57.7%). Most (57.7%) performed their 2MWT with a walker. Table 1 outlines the demographic and amputation-specific characteristics of the patients, as available. The average 2MWT distance was 65.7±32.2 m. Consistent with prior research,[7,12,17] a main effect of sex was detected; men (68.3±32.6m) walked further than women (58.8±30.0m), this difference reached statistical significance ($F_{1,503}$=9.03; $P$=.003; $\eta^2$=.018) but was not clinically meaningful.[36,37] In addition, as stated in earlier research,[12] there was a main effect of amputation level; patients with below-knee amputations (70.9±32.0m) walked further than those with through- or above-knee amputations (47.2±25.6m). This difference reached statistical significance ($F_{1,503}$=51.17; $P$<.001; $\eta^2$=.092) but was not clinically meaningful.[36,37] Correlational analysis confirmed a weak yet statistically significant negative relationship between age and 2MWT distance ($r$=−.32; $P$<.001).[12,39] Similarly, a weak statistically significant negative correlation between 2MWT distance and time from consultation to admission ($r$=−.23; $P$<.001) was detected.

Results of the unadjusted GLM revealed a statistically significant correlation between employment status prior to amputation and 2MWT distance at discharge ($F_{2,446}$=17.47; $P$<.001; $\eta^2$=.073). Pairwise comparisons revealed that patients who were working had a significantly greater 2MWT distance score than those who were not working ($P$=.021) and those who were retired ($P$<.001); those who were not working had a significantly greater 2MWT distance than those who were retired ($P$=.001). The threshold for clinical importance was not reached when comparing 2MWT distances between employment status groups. No statistically significant correlation was detected between income group and 2MWT distance at discharge ($F_{4,446}$=.714; $P$=.583; $\eta^2$=.006). The unadjusted average 2MWT distances for patients based on employment status and income bracket can be found in table 2.

After accounting for sex, amputation level, age, and time from consultation to admission, the statistically significant correlation between preamputation employment status and 2MWT distance at discharge remained ($F_{2,434}$=5.59; $P$=.004; $\eta^2$=.025). Pairwise comparisons revealed that patients who were working had a significantly greater 2MWT distance score than those who were not working ($P$=.003) and those who were retired ($P$<.024). The threshold for clinical importance was not reached when comparing 2MWT distances between employment status groups. The correlation between income bracket and 2MWT distance at discharge remained insignificant ($F_{4,434}$=.434; $P$=.784; $\eta^2$=.004). The adjusted average 2MWT distances for patients based on employment status and income bracket can be found in table 2.

## Discussion

This study explored the effect of preamputation employment status and median household income on 2MWT distance at discharge from a 6-week amputee rehabilitation program. Results from this study supported earlier work; men and those with below-knee amputations had greater 2MWT distance than women and patients with above- or through-knee amputations, respectively. Although the differences between sexes and amputation level reached statistical significance, the differences did not meet the threshold for clinical importance.[36,37] Results from the current sample also supported earlier work indicating a statistically significant inverse relationship between 2MWT distance and age at amputation,[12,39] as well as time from amputation to program admission.[9,15,16] Employment status but not median household income was shown to be a statistically significant predictor of 2MWT distance at program discharge, these relationships remained after controlling for age, sex, amputation level, and time from amputation to program admission.

Employment status was a statistically significant predictor of 2MWT distance in both the adjusted and unadjusted models. In both models, statistically significant differences in 2MWT distances were detected between patients who were working and not working; in the unadjusted model, those who were not working had a statistically greater 2MWT distance than those who were retired. In both the unadjusted and adjusted models, the threshold for clinical

**Table 2** Average 2MWT distances by employment status and income bracket after controlling for age and time from consult to program admission.

| | | Unadjusted Average 2MWT Distance (m) | | Adjusted Average 2MWT Distance (m) | |
|---|---|---|---|---|---|
| Characteristic | | n | Mean (95% CI) | n | Mean (95% CI) |
| Employment status | Working | 51 | 87.1 (78.5-95.7) | 51 | 70.9 (62.7-79.0) |
| | Not working | 142 | 73.1 (67.4-78.7) | 141 | 55.7 (49.7-61.7) |
| | Retired | 260 | 61.2 (57.1-65.3) | 253 | 58.0 (53.1-62.9) |
| Income category (CAD) | <$66,000 | 124 | 71.0 (64.9-77.0) | 123 | 59.3 (53.4-65.2) |
| | $66,000 to <$86,000 CAD | 138 | 70.4 (64.6-76.1) | 133 | 59.4 (53.8-65.0) |
| | $86,000 to <$106,000 CAD | 78 | 74.8 (67.6-82.0) | 77 | 62.1 (55.3-68.9) |
| | $106,000 to <$126,000 CAD | 80 | 73.8 (66.7-80.9) | 79 | 61.4 (54.7-68.1) |
| | ≥$126,000 | 33 | 79.0 (68.2-89.8) | 33 | 65.3 (55.3-75.3) |

Abbreviations: CAD, Canadian dollar.

significance between employment status groups was not reached.[36,37] The results suggest that employment status may affect rehabilitation outcomes. It is possible that this relationship is connected to the known relationship between employment and better physical health.[40] From a physical perspective, those who were working prior to their amputation may have had higher daily functional demands and, concomitantly, higher baseline functionality, thereby promoting superior postrehabilitation function.[8,41,42] It is also possible that patients who were working may have had an additional source of motivation to push themselves in rehabilitation in hopes of returning to their previous roles.[8,43] Future research should explore the relationship between preamputation employment status and postrehabilitation outcomes. This relationship should be explored through a physical and mental health lens.[44,45]

It is well established that lower socioeconomic status is correlated with higher rates of amputations[7,8] and poorer health outcomes[46]; however, there is limited evidence exploring the effect of preamputation income on postrehabilitation function. The results of the current study found no statistically significant contribution of income level on 2MWT distance at discharge. The lack of statistically significant correlation does not necessarily imply that socioeconomic status does not affect function after rehabilitation. Rather, this may speak to the efficacy of standardized rehabilitation programs of providing equal amenities and therapeutic resources. Our program is publicly funded; although this does not erase all inequalities to program entry or program participation, there are no out-of-pocket costs associated with attending our program. In addition, patients with insufficient or no third-party insurance coverage for a prosthesis can receive financial support from nonprofit organizations. These factors could lead to more uniform outcomes at discharge. The relationship between income and 2MWT distance at discharge should be explored in areas where publicly funded programs are not available.

### Study limitations

The retrospective nature of this study introduces several limitations that should be considered. The largest limitation was the difficulty in collecting SDH factors from medical charts. For instance, household income was not clearly stated; therefore, postal codes had to be used to estimate this variable. Although the use of postal codes to estimate demographic data is relatively reliable,[47] especially in urban centers, there is no way to confirm that the household incomes used were representative of patient income. In addition, the current study had to categorize employment on a very basic level, which may have limited conclusions. Future research should be prospective in nature to adequately collect SDH data including education, living situation, housing conditions, food insecurity, income, employment information (eg, status, type, date of leave), and race. Collecting these data could allow for greater exploration into the potential relationship between employment and rehabilitation outcomes, including 2MWT distance. Prospective studies should further be designed to obtain larger sample sizes to ensure adequate numbers in each category (ie, working, not working, and retired). Furthermore, future studies should plan for a consistent long-term regular follow-up to better understand the effect of contextual factors on long-term patient disability and function. Functional outcome measures at discharge represent "capacity" because it is in a protected environment; follow-up measures would be more representative of "performance."

## Conclusions

The current study used a large sample of dysvascular lower-limb adult amputee patients to explore the effect of preamputation employment and household income on 2MWT distance after a 6-week rehabilitation program. The results suggested that preamputation employment status was a significant predictor of 2MWT distance at discharge, whereas median household income was not. Although 2MWT distance between employment groups were statistically different, they were not clinically significant. It is possible that employment may affect a patient's level of baseline functioning and motivation, thereby affecting their rehabilitation outcomes; however, more research is needed. Results may be generalizable to adult dysvascular lower-limb amputees in Canada. Future research is needed to explore amputees from nonpublicly funded areas and to further explore

the relationship between employment and postrehabilitation function.

## Suppliers

a. SPSS Statistical Software, version 26; IBM.

## Corresponding author

Jessica Murphy, PhD, Division of Physical Medicine and Rehabilitation, McMaster University, 300 Wellington Street North, Hamilton, Ontario L8L 0A4, Canada. *E-mail address:* murphj11@mcmaster.ca.

## Acknowledgments

The authors would like to acknowledge Dr. Maxwell Goodwin for his contribution to data extraction.

## References

1. Imam B, Miller WC, Finlayson HC, Eng JJ, Jarus T. Incidence of lower limb amputation in Canada. Can J Public Health 2017;108:e374–80. https://doi.org/10.17269/CJPH.108.6093.
2. Czerniecki JM, Turner AP, Williams RM, Hakimi KN, Norvell DC. The effect of rehabilitation in a comprehensive inpatient rehabilitation unit on mobility outcome after dysvascular lower extremity amputation. Arch Phys Med Rehabil 2012;93:1384–91. https://doi.org/10.1016/j.apmr.2012.03.019.
3. AlSofyani MA, AlHarthi AS, Farahat FM, Abuznadah WT. Impact of rehabilitation programs on dependency and functional performance of patients with major lower limb amputations. A retrospective chart review in western Saudi Arabia. Saudi Med J 2016;37:1109–13. https://doi.org/10.15537/smj.2016.10.16033.
4. Stineman MG, Kwong PL, Kurichi JE, et al. The effectiveness of inpatient rehabilitation in the acute postoperative phase of care after transtibial or transfemoral amputation: study of an integrated health care delivery system. Arch Phys Med Rehabil 2008;89:1863–72. https://doi.org/10.1016/j.apmr.2008.03.013.
5. Government of Canada. Social determinants of health and health inequalities. Available at: https://www.canada.ca/en/public-health/services/health-promotion/population-health/what-determines-health.html. Accessed November 15, 2021.
6. The World Health Organization (WHO). Social determinants of health. Available at: https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1. Accessed November 15, 2021.
7. Budinski S, Manojlović V, Knežević A. Predictive factors for successful prosthetic rehabilitation after vascular transtibial amputation. Acta Clin Croat 2021;60:657–64. https://doi.org/10.20471/acc.2021.60.04.13.
8. Hamamura S, Chin T, Kuroda R, et al. Factors affecting prosthetic rehabilitation outcomes in amputees of age 60 years and over. J Int Med Res 2009;37:1921–7. https://doi.org/10.1177/147323000903700630.
9. Fajardo-Martos I, Roda O, Zambudio-Periago R, Bueno-Cavanillas A, Hita-Contreras F, Sánchez-Montesinos I. Predicting successful prosthetic rehabilitation in major lower-limb amputation patients: a 15-year retrospective cohort study. Braz J Phys Ther 2018;22:205–14. https://doi.org/10.1016/j.bjpt.2017.08.002.
10. Raya MA, Gailey RS, Gaunaurd IA, et al. Amputee mobility predictor-bilateral: a performance-based measure of mobility for people with bilateral lower-limb loss. J Rehabil Res Dev 2013;50:961–8. https://doi.org/10.1682/JRRD.2012.05.0097.
11. Erjavec T, Vidmar G, Burger H. Exercise testing as a screening measure for ability to walk with aprosthesis after transfemoral amputation due to peripheral vascular disease. Disabil Rehabil 2014;36:1148–55. https://doi.org/10.3109/09638288.2013.833307.
12. Gaunaurd I, Kristal A, Horn A, et al. The utility of the 2-minute walk test as a measure of mobility in people with lower limb amputation. Arch Phys Med Rehabil 2020;101:1183–9. https://doi.org/10.1016/j.apmr.2020.03.007.
13. Karmarkar AM, Graham JE, Reistetter TA, et al. Association between functional severity and amputation type with rehabilitation outcomes in patients with lower limb amputation. Rehabil Res Pract 2014;2014:961798. https://doi.org/10.1155/2014/961798.
14. O'Neill BF, Evans JJ. Memory and executive function predict mobility rehabilitation outcome after lower-limb amputation. Disabil Rehabil 2009;31:1083–91. https://doi.org/10.1080/09638280802509579.
15. Sansam K, Neumann V, O'Connor R, Bhakta B. Predicting walking ability following lower limb amputation: a systematic review of the literature. J Rehabil Med 2009;41:593–603. https://doi.org/10.2340/16501977-0393.
16. Stineman MG, Kwong PL, Xie D, et al. Prognostic differences for functional recovery after major lower limb amputation: effects of the timing and type of inpatient rehabilitation services in the Veterans Health Administration. PM R 2010;2:232–43. https://doi.org/10.1016/j.pmrj.2010.01.012.
17. Brooks D, Parsons J, Hunter JP, Devlin M, Walker J. The 2-minute walk test as a measure of functional improvement in persons with lower limb amputation. Arch Phys Med Rehabil 2001;82:1478–83. https://doi.org/10.1053/apmr.2001.25153.
18. van Velzen JM, van Bennekom CA, Polomski W, Slootman JR, van der Woude LH, Houdijk H. Physical capacity and walking ability after lower limb amputation: a systematic review. Clin Rehabil 2006;20:999–1016. https://doi.org/10.1177/0269215506070700.
19. Norvell DC, Turner AP, Williams RM, Hakimi KN, Czerniecki JM. Defining successful mobility after lower extremity amputation for complications of peripheral vascular disease and diabetes. J Vasc Surg 2011;54:412–9. https://doi.org/10.1016/j.jvs.2011.01.046.
20. World Health Organization. Towards a common language for functioning, disability and health (ICF). Available at: https://cdn.who.int/media/docs/default-source/classification/icf/icf-beginnersguide.pdf. Accessed October 21, 2023.
21. Darter BJ, Hawley CE, Armstrong AJ, Avellone L, Wehman P. Factors influencing functional outcomes and return-to-work after amputation: a review of the literature. J Occup Rehabil 2018;28:656–65. https://doi.org/10.1007/s10926-018-9757-y.
22. Lee SP, Chien LC, Shih HT, Ho S, Clemens S. Returning to work after dysvascular lower limb amputation-a novel multivariate approach to examine relative contributions of biopsychosocial predictors. Prosthet Orthot Int 2024. https://doi.org/10.1097/PXR.0000000000000322. Jan 5. [Epub ahead of print].
23. Butland RJ, Pang J, Gross ER, Woodcock AA, Geddes DM. Two-, six-, and 12-minute walking tests in respiratory disease. Br Med J (Clin Res Ed) 1982;284:1607–8. https://doi.org/10.1136/bmj.284.6329.1607.
24. Reid L, Thomson P, Besemann M, Dudek N. Going places: does the two-minute walk test predict the six-minute walk test in lower extremity amputees? J Rehabil Med 2015;47:256–61. https://doi.org/10.2340/16501977-1916.

25. Guyatt GH, Sullivan MJ, Thompson PJ, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. Can Med Assoc J 1985;132:919–23.
26. Lord SR, Menz HB. Physiologic, psychologic, and health predictors of 6-minute walk performance in older people. Arch Phys Med Rehabil 2002;83:907–11. https://doi.org/10.1053/apmr.2002.33227.
27. Harada ND, Chiu V, Stewart AL. Mobility-related function in older adults: assessment with a 6-minute walk test. Arch Phys Med Rehabil 1999;80:837–41. https://doi.org/10.1016/S0003-9993(99)90236-8.
28. Demir Y, Aydemir K. Gülhane lower extremity amputee rehabilitation protocol: a nationwide, 123-year experience. Turk J Phys Med Rehabil 2020;66:373–82. https://doi.org/10.5606/tftrd.2020.7637.
29. Murray L, McGinty G. Use of physical activity measures in rehabilitation interventions following lower extremity amputation. Curr Phys Med Rehabil Rep 2023;11:25–34. https://doi.org/10.1007/s40141-023-00383-w.
30. Hebert JS, Wolfe DL, Miller WC, Deathe AB, Devlin M, Pallaveshi L. Outcome measures in amputation rehabilitation: ICF body functions. Disabil Rehabil 2009;31:1541–54. https://doi.org/10.1080/09638280802639467.
31. Gremeaux V, Damak S, Troisgros O, et al. Selecting a test for the clinical assessment of balance and walking capacity at the definitive fitting state after unilateral amputation: a comparative study. Prosthet Orthot Int 2012;36:415–22. https://doi.org/10.1177/0309364612437904.
32. Orendurff MS, Segal AD, Berge JS, Flick KC, Spanier D, Klute GK. The kinematics and kinetics of turning: limb asymmetries associated with walking a circular path. Gait Posture 2006;23:106–11. https://doi.org/10.1016/j.gaitpost.2004.12.008.
33. Parker K, Kirby RL, Adderson J, Thompson K. Ambulation of people with lower-limb amputations: relationship between capacity and performance measures. Arch Phys Med Rehabil 2010;91:543–9. https://doi.org/10.1016/j.apmr.2009.12.009.
34. Statistics Canada. Census Profile. Available at: https://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E&TABID=2. Accessed August 29, 2024.
35. IBM. SPSS Statistical Software version 26. Available at: https://www.ibm.com/spss. Accessed August 29, 2024.
36. Carse B, Scott H, Davie-Smith F, Brady L, Colvin J. Minimal clinically important difference in walking velocity, gait profile score and two minute walk test for individuals with lower limb amputation. Gait Posture 2021;88:221–4. https://doi.org/10.1016/j.gaitpost.2021.06.001.
37. Resnik L, Borgia M. Reliability of outcome measures for people with lower-limb amputations: distinguishing true change from statistical error. Phys Ther 2011;91:555–65. https://doi.org/10.2522/ptj.20100287.
38. Miles J. Tolerance and variance inflation factor. In: Everitt BS, Howell DC, eds. Encyclopedia of Statistics in Behavioral Science, Hoboken: John Wiley & Sons, Ltd.; 2005.
39. Bohannon R, Wang YC, Gershon RC. Two-minute walk test performance by adults 18 to 85 years: normative values, reliability, and responsiveness. Arch Phys Med Rehabil 2015;96:472–7. https://doi.org/10.1016/j.apmr.2014.10.006.
40. Hergenrather KC, Zeglin RJ, McGuire-Kuletz M, Rhodes SD. Employment as a social determinant of health: a systematic review of longitudinal studies exploring the relationship between employment status and physical health. Rehabil Res Policy Educ 2015;29:2–26. https://doi.org/10.1891/2168-6653.29.1.2.
41. Venkataraman K, Fong NP, Chan KM, et al. Rehabilitation outcomes after inpatient rehabilitation for lower extremity amputations in patients with diabetes. Arch Phys Med Rehabil 2016;97:1473–80. https://doi.org/10.1016/j.apmr.2016.04.009.
42. Kahle JT, Highsmith MJ, Schaepper H, Johannesson A, Orendurff MS, Kaufman K. Predicting walking ability following lower limb amputation: an updated systematic literature review. Technol Innov 2016;18:125–37. https://doi.org/10.21300/18.2-3.2016.125.
43. MacKenzie EJ, Bosse MJ, Pollak AN, et al. Long-term persistence of disability following severe lower-limb trauma. Results of a seven-year follow-up. J Bone Joint Surg Am 2005;87:1801–9. https://doi.org/10.2106/JBJS.E.00032.
44. Smith-Carrier T, Kerr D, Wang J, Tam DMY, Kwok SM. Vestiges of the medical model: a critical exploration of the Ontario Disability Support Program in Ontario, Canada. Disabil Soc 2017;32:1570–91. https://doi.org/10.1080/09687599.2017.1359495.
45. O'Neill EA. Relationships between physical health and employment among people with serious mental illness. Soc Work Res 2021;45:30–42. https://doi.org/10.1093/swr/svaa025.
46. Hajizadeh M, Mitnitski A, Rockwood K. Socioeconomic gradient in health in Canada: is the gap widening or narrowing? Health Policy 2016;120:1040–50. https://doi.org/10.1016/j.healthpol.2016.07.019.
47. Pinault L, Khan S, Tjepkema M. Accuracy of matching residential postal codes to consensus geography. Health Rep 2020;31:3–13. https://doi.org/10.25318/82-003-x202000300001-eng.